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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/668,986	09/22/2003	Valery M. Dubin	10559/856001 / P17304/Int	1755

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EXAMINER

IM, JUNGHWA M

ART UNIT	PAPER NUMBER
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2811

DATE MAILED: 12/13/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/668,986

Applicant(s)

DUBIN ET AL.

Examiner

Junghwa M. Im

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 August 2006.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-40 is/are pending in the application.
- 4a) Of the above claim(s) 15-31 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 5,12 and 34-38 is/are allowed.
- 6) ☒ Claim(s) 1-4,6-11,13,14,32 and 33 is/are rejected.
- 7) ☒ Claim(s) 39 and 40 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 29 November 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on August 16, 2006 has been entered.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claim 13 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Claim 13 recites the limitation "the base metal layer further contacts the diffusion barrier layer to physically isolate the bump from the solder layer." This is not appeared to be possible since the instant invention discloses that the diffusion barrier is formed between the Cu base layer and the bump layer, and the solder layer is in direct contact with the bump layer.

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The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claim 13 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 13 recites the limitation "the base metal layer further contacts the diffusion barrier layer to physically isolate the bump from the solder layer." This recitation is confusing since this aspect is not disclosed in the instant invention.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claim 1, 2 and 32 are rejected under 35 U.S.C. 102(e) as being anticipated by Sakuyama et al. (US Pat. 6,689,639), hereinafter Sakuyama.

Regarding claim 1, Fig. 4B of Sakuyama shows an apparatus, comprising:

a semiconductor substrate (10);

a first conducting layer (11) in contact with the semiconductor substrate, the first conducting layer comprising a base layer metal, the base layer metal comprising Cu (col. 6, lines 32-33);

a diffusion barrier (22) in contact with the first conducting layer, wherein the diffusion barrier comprises a metal alloy comprising boron and phosphorous (col. 4, lines 59-65; col. 6, lines 48-51);

a wetting layer (23; col. 7, lines 9-12) on top of the diffusion barrier; and

a bump layer (41) on top of the wetting layer, the bump layer comprising Sn (col. 7, lines 38-43) and wherein the diffusion barrier being formed configured to prevent Cu and Sn from diffusing through the diffusion barrier and to prevent CuSn intermetallic formation in the apparatus (col. 6, lines 51-53; col. 1, lines 55-59).

Regarding claim 2, it is inherent that the diffusion barrier of Sakuyama's device is configured to suppress whisker-type formation in the bump layer since whisker-type formation in the bump layer is caused due to the CuSn intermetallic reaction between the Cu conducting layer and the Sn bump.

the material for the diffusion barrier layer of Sakuyama's device is substantially identical to the one in the instant invention.

Regarding claim 32, Fig. 4B of Sakuyama shows a circuit board (70 in Fig. 5) comprising:

one or more components comprising circuitry (X; semiconductor device); and

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one or more layers (71) on the circuit board to route at least one signal between components on the circuit board, wherein at least one of the components on the circuit board comprises a die packing interconnect comprising:

a semiconductor substrate (10);

a first conducting layer (11) in contact with the semiconductor substrate, the first conducting layer comprising a base layer metal, the base layer metal comprising Cu (col. 6, lines 32-33);

a diffusion barrier (22) in contact with the first conducting layer, wherein the diffusion barrier comprises a metal alloy comprising boron and phosphorous (col. 4, lines 59-65; col. 6, lines 48-51);

a wetting layer (23; col. 7, lines 9-12) on top of the diffusion barrier; and

a bump layer (41) on top of the wetting layer, the bump layer comprising Sn (col. 7, lines 38-43), the diffusion barrier being configured to prevent Cu and Sn from diffusing through the diffusion barrier and to prevent CuSn intermetallic formation in the die packing interconnection (col. 6, lines 51-53; col. 1, lines 55-59).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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Claims 3, 7, 9, 10 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakuyama in view of Sambucetti et al. (US Pat. 6,335,104), hereinafter Sambucetti.

Regarding claim 3, Fig. 4B of Sakuyama shows most aspects of the instant invention including a die package (70 in Fig. 5) and a solder material of Sn (col. 7, lines 38-44), however, fails to show a solder layer positioned between the bump layer and a die package, wherein the solder layer comprises Sn. Sambucetti discloses that a solder layer positioned between the bump layer and a die package and the solder layer comprises Sn (C4 joining process; col. 1, lines 50-55).

It is also pointed out that it is obvious and well known to one of ordinary skill in the art that that a solder layer comprises Sn.

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Sambucetti into the device of Sakuyama in order to have a solder layer comprising Sn positioned between the bump layer and a die package to enhance the bonding between the semiconductor device and the package substrate/board.

Regarding claim 7, Fig. 4B of Sakuyama shows most aspects of the instant invention except the wetting layer comprises NiP. Fig. 2 of Sambucetti shows the wetting layer (18) comprises NiP, (col. 6, lines 29-30) wherein the diffusion barrier is further configured to reduce bump layer delamination (lift-off defect; col. 1, lines 39-50).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Sambucetti into the device of Sakuyama in order to have the wetting layer comprising NiP to increase the adhesion of the underlying conductive

layer to the bump layer and the diffusion barrier configured to reduce bump layer delamination to enhance the bonding the property of the bump layer.

Furthermore, it is pointed out that the diffusion barrier of Sakuyama is also figured to reduce bump layer delamination though preventing CuSn intermetallic formation.

Regarding claim 9, Fig. 4B of Sakuyama shows an apparatus, comprising:

a base layer metal (11) on a semiconductor substrate, the base layer metal comprising Cu (col. 6, lines 32-33);

a bump (41) on top of the base layer metal, the bump comprising a Cu layer (col. 7, lines 38-43);

a diffusion barrier (22) in contact with the bump layer, the diffusion barrier comprises a metal alloy comprising boron and phosphorous (col. 4, lines 59-65; col. 6, lines 48-51);

a wetting layer (23; col. 7, lines 9-12) on top of the diffusion barrier; and

the diffusion barrier being further configured to prevent the diffusion of Cu and Sn [of the bump layer] through the diffusion barrier and to prevent CuSn intermetallic formation in the apparatus (col. 6, lines 51-53; col. 1, lines 55-59).

Fig. 4B of Sakuyama shows most aspects of the instant invention including a solder material of Sn (col. 7, lines 38-44), however, fails to show “a solder layer contacting the bump, the solder layer comprising Sn.” Sambucetti discloses that a solder layer between the bump and the package substrate and the solder layer comprises Sn (C4 joining process; col. 1, lines 50-55).

It is also pointed out that it is obvious and well known to one of ordinary skill in the art that that a solder layer comprises Sn.

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Sambucetti into the device of Sakuyama in order to have a solder layer comprising Sn contacting the bump to enhance the bonding between the semiconductor device and an electrode on the package substrate/board.

Regarding claim 10, it is obvious that the diffusion barrier of Sakuyama's device is configured to suppress whisker-type formation in the bump layer since whisker-type formation in the bump layer is caused due to the CuSn intermetallic reaction between the Cu conducting layer and the Sn bump.

Regarding claim 13, insofar as understood, Fig. 4B of Sakuyama shows an apparatus, comprising:

- a base layer metal (11) on a semiconductor substrate, the base layer metal comprising Cu (col. 6, lines 32-33);

- a bump (41) on top of the base layer metal, the bump comprising a Cu layer (col. 7, lines 38-43);

- a diffusion barrier (22) in contact with the bump layer, the diffusion barrier comprises a metal alloy comprising boron and phosphorous (col. 4, lines 59-65; col. 6, lines 48-51);

- a wetting layer (23; col. 7, lines 9-12) on top of the diffusion barrier; and

the diffusion barrier being further configured to prevent the diffusion of Cu and Sn [of the bump] through the diffusion barrier and to prevent CuSn intermetallic formation in the apparatus (col. 6, lines 51-53; col. 1, lines 55-59).

Fig. 4B of Sakuyama shows most aspects of the instant invention including a solder material of Sn (col. 7, lines 38-44), however fails to show "a solder layer on top of the wetting

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layer, the solder layer comprising Sn.” Sambucetti discloses that a solder layer on top of the wetting layer, that is, a solder layer on the bump (C4 joining process; col. 1, lines 50-55).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Sambucetti into the device of Sakuyama in order to have a solder layer comprising Sn on top of the wetting layer /bump to enhance the bonding between the semiconductor device and an electrode on the package substrate/board.

Claims 4 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakuyama in view of Hongo et al. (US Pub. 2002/0127790), hereinafter Hongo.

Regarding claims 4 ad 8, Fig. 4B of Sakuyama fails to show that the base layer metal comprises another base metal layer such as an adhesion layer and a seed layer comprising Co. Fig. 1 C of Hongo shows a Cu base layer (6) comprises an adhesion layer (5) and a seed layer (7) comprising Co (paragraphs [0048] and [0049]).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Hongo into the device of Sakuyama in order to have an the adhesion and a seed layer comprised of Co to prevent the diffusion of the Cu into the neighboring layers.

Claims 6 and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakuyama in view of Kong et al. (US Pat. 6,797,312), hereinafter Kong.

Regarding claim 6, Fig. 4B of Sakuyama show most aspects of the instant invention including that the bump layer comprises a Sn alloy, the Sn alloy comprising one of 0.7Cu, Bi and

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Sb, wherein the bump layer is further configured to prevent low temperature phase transition of Sn from alpha Sn into beta Sn (col. 7, lines 38-43), however, fails to show that the diffusion barrier comprises NiWBP. Kong discloses that a diffusion barrier layer comprises NiWBP (col. 1, lines 25-30 and col. 3, line 63 - col. 4, line 6).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Kong into the device of Sakuyama in order to have the diffusion barrier comprising NiWBP to improve the barrier property.

Note that it is obvious that the bump layer of Sakuyama's device is configured to prevent low temperature phase transition of Sn from alpha Sn into beta Sn since the material for the bump layer of Sakuyama's device is identical to the one disclosed in the instant invention.

Regarding claim 33, Fig. 4B of Sakuyama show most aspects of the instant invention including the one of the components is a memory/electronic component (col. 1, lines 11-13), however, fails to show that the diffusion barrier comprises NiWBP. Kong discloses that a diffusion barrier layer comprises NiWBP (col. 1, lines 25-30 and col. 3, line 63 - col. 4, line 6).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Kong into the device of Sakuyama in order to have the diffusion barrier comprising NiWBP to improve the barrier property.

Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sakuyama in view of Sambucetti as applied to claim 9 above, and further in view of Hongo.

Regarding claim 11, the combination of Sakuyama/Sambucetti fails to show that the base layer metal comprises an adhesion layer and a seed layer comprising Co. Fig. 1 C of Hongo

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shows a Cu base layer (6) comprises an adhesion layer (5) and a seed layer (7) comprising Co (paragraphs [0048] and [0049]).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Hongo into the device of Sakuyama/Sambucetti in order to have an the adhesion and a seed layer comprised of Co to improve the bonding property of the Cu layer.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sakuyama in view of Sambucetti as applied to claim 9 above, and further in view of Kong.

Regarding claim 14, the combination of Sakuyama/Sambucetti shows most aspects of the instant invention including the wetting layer (18) comprising NiP (col. 6, lines 29-30), however, fails to show the diffusion barrier comprises NiWBP. Kong discloses that a diffusion barrier layer comprises NiWBP (col. 1, lines 25-30 and col. 3, line 63 - col. 4, line 6).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the teachings of Kong into the device of Sakuyama/Sambucetti in order to have the diffusion barrier comprising NiWBP to improve the barrier property.

Allowable Subject Matter

Claims 5, 12 and 34-38 are allowed.

Claims 39 and 40 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is an examiner's statement of reasons for allowance: The reference of record fails to teach or suggest, either singularly or in combination at least the limitation of "the base layer metal further comprises a metal layer positioned between the adhesion layer and the seed layer, wherein the metal layer comprises Al."

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Arguments

Applicant's arguments with respect to pending claims have been considered but are moot in view of the new ground(s) of rejection.

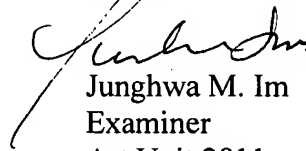
Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Junghwa M. Im whose telephone number is (571) 272-1655. The examiner can normally be reached on MON.-FRI. 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on (571) 272-1732. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Junghwa M. Im
Examiner
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jmi
10/30/2006